COST is supported by the EU Framework Programme Horizon 2020

AOD measurement and data processing - II -

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Henri Dièmoz has already given a complete overview of the determination of the AOD using Brewer instruments

I will now just give you some details on how we calculate the AOD at the RBCCE

The RBCCE team (left to right, top to bottom):

Alberto Redondas (AEMET)
Alberto Berjon (ULL, ATMOZ)
Javier López Solano (ULL, IDEAS)
Bentorey Hernandez (ULL, PANDONIA)
Virgilio Carreño (AEMET)
Manuel Rodriguez Valido (ULL)
Daniel Santana (ULL,PANDONIA)
Sergio Fabián León Luis (AEMET)

Lambert equation for the Brewer

$$\tau_a = \frac{1}{\mu_R}\left\{ \ln I_0 - \ln I - X_{O3}\sigma_{O3}\mu_{O3} - \frac{p}{1013}\delta_R\mu_R \right\}$$

where we have

1) approximated the aerosol air mass by the Rayleigh air mass μ_R
2) neglected other contributions to the AOD besides those of the ozone and Rayleigh scattering (e.g., SO_2 is missing)

Reminder: there is one such equation for each slit (wavelength)

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Extraterrestrial constant

$$\tau_a = \frac{1}{\mu_R}\left\{ \ln I_0 - \ln I - X_{O3}\sigma_{O3}\mu_{O3} - \frac{p}{1013}\delta_R\mu_R \right\}$$

determined by

1) the Langley-plot method for reference instruments (e.g., Brewer #185 from the RBCCE triad)
2) calibration transfer using simultaneous measurements with a reference during, e.g., Brewer intercomparison campaigns

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Counts per second

$$\tau_a = \frac{1}{\mu_R}\left\{\ln I_0 - \ln I - X_{O3}\sigma_{O3}\mu_{O3} - \frac{p}{1013}\delta_R\mu_R\right\}$$

Raw counts for each slit converted to counts/second taking into account the effect of dark counts and dead time, plus

1) Data-quality filters from EUBREWNET's Level 1.5 product
2) Polarization correction from Cede *et al*. 2006 or Dièmoz *et al*. 2016
3) Correction for the Earth-Sun distance variation using Spencer 1971, as quoted by Iqbal 1983

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Counts per second (2)

$$\tau_a = \frac{1}{\mu_R}\left\{ \ln I_0 - \ln I - X_{O3}\sigma_{O3}\mu_{O3} - \frac{p}{1013}\delta_R\mu_R \right\}$$

4) Filter and temperature corrections using parameters determined at the calibration campaigns:

i) Filter attenuation coefficients with spectral dependence

ii) Temperature coefficients not normalized to the first slit

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Ozone

$$\tau_a = \frac{1}{\mu_R}\left\{\ln I_0 - \ln I - X_{O3}\,\sigma_{O3}\,\mu_{O3} - \frac{p}{1013}\,\delta_R\,\mu_R\right\}$$

EUBREWNET's Level 1.5 product:

Counts from B files, configurations in the server, ozone processed with the Brewer Python Module

Cloud, airmass, and Hg filters

Standard lamp, filter, and stray-light corrections

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Spectral coefficients

$$\tau_a = \frac{1}{\mu_R}\left\{ \ln I_0 - \ln I - X_{O3}\,\sigma_{O3}\,\mu_{O3} - \frac{p}{1013}\,\delta_R\,\mu_R \right\}$$

Instrumental slit function from calibration (provides the wavelength & FWHM), convoluted with

- Bass-and-Paur’s ozone absorption cross sections: σ_{O3}
- Bodhaine’s Rayleigh coefficients: δ_R

See A. Redondas’ poster “Wavelength characterization of Brewer spectrophotometer with a tunable laser at PTB facilities” (P227, QOS2016-303) for more details!

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Air masses and pressure

$$\tau_a = \frac{1}{\mu_R}\left\{ \ln I_0 - \ln I - X_{O3}\sigma_{O3}\mu_{O3} - \frac{p}{1013}\delta_R\mu_R \right\}$$

As in the standard Brewer algorithm:

- μ_{O3} ozone air mass
- μ_R Rayleigh air mass
- p climatological pressure at the Brewer site

Reminder: the Rayleigh air mass is also used for the aerosol term

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AOD configuration parameters

One calibration constant I_0 for each slit

One attenuation coefficient for each slit and filter

One non-normalized temperature coefficient for each slit

One ozone absorption cross section σ_{O3} for each slit

One Rayleigh coefficient δ_R for each slit

All these parameters are currently being determined at the RBCCE campaigns!

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AOD configuration at EUBREWNET's data server

Preliminary template:

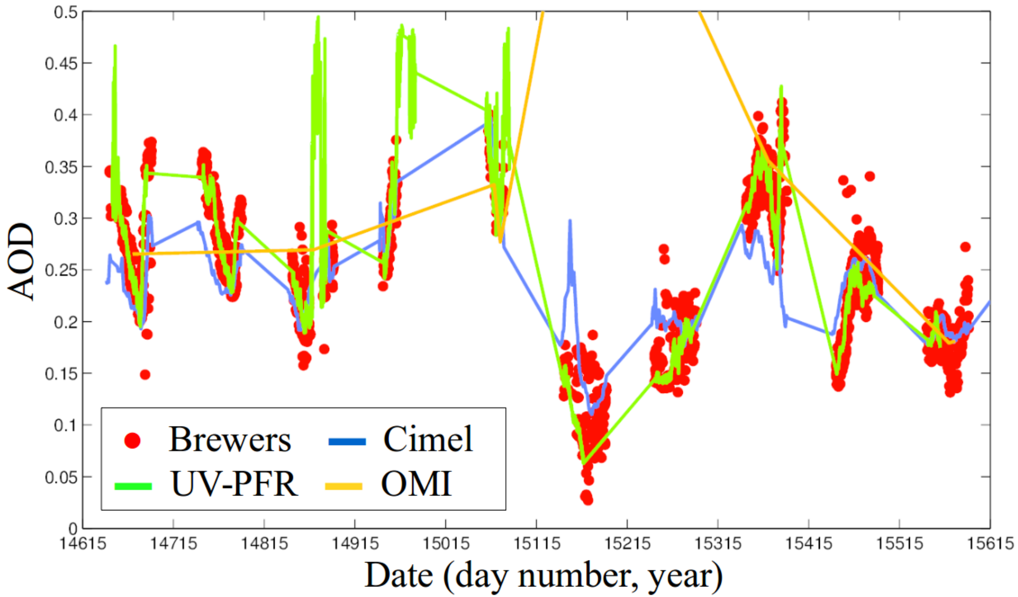
Slit	Cal step	Wavelength	FWHM	Cal const	Rayleigh coeff	O3 abs coeff	SO2 abs coeff	T coeff const	T coeff wl	Filter 1 att	Filter 2 att	Filter 3 att	Filter 4 att	Filter 5 att	StrayL const	StrayL exp	SL ref
0	1024	303.2	0.6	NaN	0	NaN	0	0	0	NaN	10225	14931	21430	NaN	0	0	0
2	1024	306.3	0.6	8.07E+04	4870	1.7807	0	0	0	NaN	10205	14815	21245	NaN	0	0	0
3	1024	310.1	0.6	7.97E+04	4620	1.0049	0	0	-0.2	NaN	10185	14691	21044	NaN	0	0	0
4	1024	313.5	0.6	8.18E+04	4410	0.6767	0	0	-0.2	NaN	10172	14590	20880	NaN	0	0	0
5	1024	316.8	0.6	8.19E+04	4220	0.3751	0	0	0	NaN	10159	14504	20738	NaN	0	0	0
6	1024	320.1	0.6	8.23E+04	4040	0.2938	0	0	0.7	NaN	10151	14432	20615	NaN	0	0	0

Will be inserted as a plain text file

Extra parameters → future proof

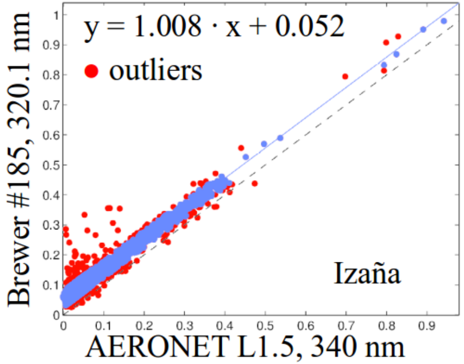
X RBCCE Brewer intercomparison campaign

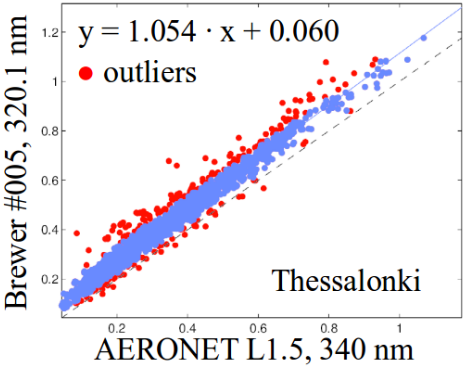
- 21 Brewers at El Arenosillo (Huelva, Spain), May-June 2015
- Reference Brewer #185 calibrated by the Langley method at Izaña
- Good agreement with UV-PFR, Cimel and OMI data

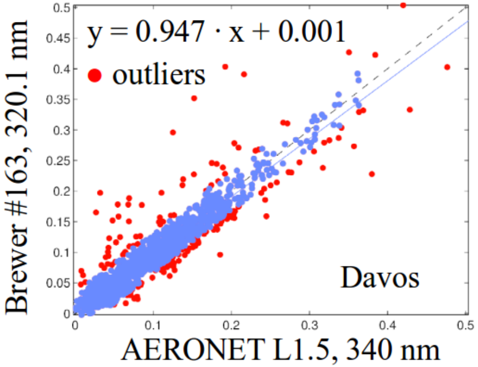


2015-2016

- Brewers operating at their own stations
- Calibration from the X RBCCE campaign
- Good agreement with collocated Cimels







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For more details, see poster P191, QOS2016-91

P191
QOS2016-91

Aerosol optical depth in the ultraviolet range: a new product in EUBREWNET

EUBREWNET

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Closing remarks

For the Brewers taking part in the RBCCE campaigns, we already have all the data needed to calculate the AOD

We find a good agreement with products from the UV-PFR, Cimel, and OMI instruments

The Brewer AOD product should be available soon at EUBREWNET's data server:

http://rbcce.aemet.es/eubrewnet